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PATENT **Docket No. Kermani 14**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTORS:	**Bahram G. Kermani**	Examiner: J. Hirl Art Unit: 2121
APPLICATION NO.	**09/427,802**	
FILED:	**October 27, 1999**	
TITLE:	**FUZZY LOGIC SYSTEM WITH EVOLUTIONARY VARIABLE RULES**	

CERTIFICATE OF MAIL

I hereby certify that this paper is being deposited with the U.S. Postal Service as First Class Mail, postage prepaid, in an envelope addressed to Commissioner for Patents, MAIL STOP AF, P.O. Box 1450, Alexandria, VA 22313-1450, Attention: Board of Patent Appeals and Interferences on June 25, 2003.

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APPELLANTS' BRIEF

This brief is in furtherance of the Notice of Appeal filed in this case on April 22, 2003.

This brief is transmitted in triplicate.

1. REQUIRED FEE

The requisite fee ($320.00) set forth in §1.17(f) is enclosed.

2. REAL PARTY IN INTEREST

The present application is assigned to Agere Systems Inc., having its principal place of business at 555 Union Boulevard, Allentown, Pennsylvania 18109. Accordingly, Agere Systems Inc. is the real party in interest.

3. RELATED APPEALS AND INTERFERENCES

The appellant, assignee, and the legal representatives of both are unaware of any other appeal or interference which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

4. STATUS OF CLAIMS

A. Claims canceled: None

B. Claims withdrawn from consideration but not canceled: None

C. Claims pending: 1-20

D. Claims allowed: None

E. Claims rejected: 1-20

F. Claims appealed: 1-20

Appealed claims 1-20 as currently pending are attached as Appendix A hereto.

5. STATUS OF AMENDMENTS

No amendment after final was filed in the present case. A Reply under 37 C.F.R. §1.111 was filed on July 29, 2002 and resulted in the final Office Action appealed herein. A Reply under 37 CFR §1.116 was filed on January 22, 2003, but did not result in allowance by the Examiner.

6. SUMMARY OF THE CLAIMED INVENTION

The present invention relates to a fuzzy logic system with evolutionary variable rules. According to the present invention, the features, qualifiers, and operators of rules, and the rules themselves, are continually generated and evolved using **genetic algorithms**, based on real-time data. This invention is especially useful in stock market forecasting and, in particular, day-trading wherein the pertinent data may change many times over a short period of time.

First, a random set of rules (a population of chromosomes) is generated using a random selection from each of the categories of operators, features, cases, and qualifiers. Next, the population of chromosomes are evolved to improve their fitness function in a known manner. The fitness function is a cost function that penalizes the algorithm if it renders non-compliant results, i.e., results that do not logically follow the trend of the input data.

Once the fitness function **plateaus** for the population (i.e., **ceases to improve**) the resultant rule (a chromosome) is stored, e.g., in a bin, thereby creating a storage location or "binning pool" in which "optimized" rules are accumulated. The chromosomes then go

through further generation (initialization) and evolution to improve their overall fitness function. The chromosomes that are subjected to this further evolution may be a set of newly generated chromosomes (including chromosome(s) from the previous evolutionary session). This process is repeated until adding more chromosomes to the optimized rule pool does not improve the overall fitness of the pool. At this point the algorithm may be stopped and the best chromosomes then define the rules of the system. For example, if it is presumed that a optimized chromosome pool population can contain 15 chromosomes, then once 16 chromosomes have been established, an evaluation is made and the 15 fittest chromosomes are kept while the worst of the 16 is deleted.

Thus, the fuzzy logic system of the present invention creates fuzzy rules in real-time and updates the fuzzy rules dynamically. This is accomplished by using **genetic algorithms** to continually optimize the features, qualifiers, cases, and operators of the fuzzy rules until they **plateau**. The fuzzy logic system may be utilized in applications requiring constantly-updated fuzzy rules and also in applications where fuzzy rules are difficult to pre-define due to a large quantity of input data, such as, for example, stock market forecasting.

The Chidambaran et al. Reference

Chidambaran et al. teach the use of genetic programming to create a computer program that approximates the relationship between the price of a stock option, the terms of the option contract, and the properties of the underlying stock price that forms the basis for the stock option. Using genetic programming, the authors of the Chidambaran et al. reference

claim that they can create a computer program that achieves a better solution to the problem (approximating the relationship between the option price, the option contract and the underlying stock price) than the "Black-Scholes" option pricing model, a widely accepted option pricing theory used in financial markets at the time of the writing of the Chidambaran et al. reference. In accordance with Chidambaran et al., the steps of the evolutionary program are repeated for a "pre-specified number of times" and then the steps are terminated.

The Hung Reference (U.S. Patent No. 5,727,130)

Hung teaches a genetic algorithm for constructing and tuning a fuzzy logic system. The Examiner relies on Hung for an alleged teaching of the evolving of features of random rules (Hung, column 123, lines 6-10) and a teaching of using an interface of genetic algorithm with fuzzy logic systems to eliminate manually building fuzzy systems (column 3, lines 18-20).

7. ISSUES

A. ISSUE INVOLVING CLAIMS 1-20

1. Whether the Examiner improperly rejected the claims because the cited prior art fails to teach or suggest the use of genetic algorithms to improve the fitness function of rules in a random rule set in a fuzzy logic system.

2. Whether the Examiner improperly rejected the claims because the cited prior art fails to teach or suggest the process of evolving random rules to improve their fitness function until the overall fitness function of the rules plateaus.

8. GROUPING OF CLAIMS

A. Claims 1-20 stand or fall together.

9. ARGUMENT

A. The Examiner improperly rejected claims 1, 2, 7-9, and 14-20 under 35 U.S.C. §102(b) as being anticipated by Chidambaran et al. (IEEE 98th8367).

In item 6 on pages 6-9 of the final Office Action, the Examiner rejected claims 1, 2, 7-9, and 14-20 under 35 U.S.C. §102(b) as being anticipated by Chidambaran et al. (IEEE 98th8367).

The Cited Prior Art Does Not Anticipate the Claimed Invention

The MPEP and case law provide the following definition of anticipation for the purposes of 35 U.S.C. §102:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Company of California*, 814 F.2d 628, 631, 2 U.S.P.Q. 2d 1051, 1053 (Fed. Cir. 1987)

The Examiner Has Not Established a *prima facie* Case of Anticipation

The Chidambaran et al. reference is limited to genetic programming. As is well known, genetic programming provides a method for automatically creating a working computer program by genetically breeding a population of computer programs using the principles of Darwinian natural selection and biologically inspired operations. A (typically large) grouping of individual programs in a population is evaluated to determine how fit it is at solving the problem at hand. Programs are then probablistically selected from the population based on their fitness to participate in the various genetic operations, with reselection allowed. While a more fit program has a better chance of being selected, even individual programs known to be unfit are allocated some trials in a mathematically principled way. After many generations, a program emerges that solves, or approximately solves, the problem at hand.

A genetic algorithm is an algorithm that is created based on natural biological evolution. A genetic algorithm functions by generating a large set of possible solutions to a given problem. It then evaluates each of those solutions, and decides on a "fitness level" for each solution set. These solutions then breed new solutions. The parent solutions that were more "fit" are more likely to reproduce, while those that were less "fit" are more unlikely to do so. In essence, solutions are evolved over time.

The present invention has two independent claims: claim 1 and claim 9. The Examiner has rejected each of these claims, including certain of the claims depending from these independent claims, based upon the Chidambaran et al. reference. This rejection is improper. As noted above, the Chidambaran et al. reference is related to genetic programming. Each of

the claims specifically recite the use of a fundamentally different procěss, the use of genetic algorithms genetic programming and genetic algorithms are two very different concepts and Chidambaran does not each the use of genetic algorithms in any way.

Further, as admitted by the Examiner, the Chidambaran et al. reference teaches that the evolutionary process for generating the computer program is repeated "for a pre-specified number of times". In other words, a number of generations to evolve is selected ahead of time, and then when this number is reached, the process is completed. By contrast, the present invention, as specifically claimed in both independent claims 1 and 9, involves the continuing of the evolutionary process, not for a fixed, pre-determined number of generations as in Chidambaran et al., but instead, it continues until the fitness function of the rules cannot be further improved, i.e., becomes substantially constant, indicating that it has reached a plateau.

Independent claims 1 and 9 each specifically recite these features not taught or suggested by Chidambaran et al. (e.g., Claim 1: "...evolving said random rules using a genetic algorithm to improve the sitness function of said rules in said random rule set until the overall fitness function of said rules plateaus, thereby generating an optimized rule ...."). As a result, an optimized rule is generated.

The development disclosed in the Chidambaran et al. reference cannot perform the claimed functions. First, its purpose is to generate a computer program, not to improve the fitness function of rules in a random rule set of a fuzzy logic system. Further, once the predetermined number of generations has elapsed, the process of Chidambaran et al.

terminates, regardless as to whether or not any plateauing has taken place and, thus, regardless as to whether or not the computer program being generated is "optimized".

The difference between the operation of Chidambaran's invention and the claims of the present invention can be demonstrated by considering the process used to progress children through a school system. The Chidambaran patent would be comparable to a system whereby, if a second grader spends 180 school days attending second grade, they are automatically advanced to the third grade. The 180 days represents the fixed, predetermined number of generations of the present invention. It allows the child to be progressed to third grade, regardless as to whether or not their level of knowledge and skill has been increased to the level necessary to succeed in third grade. By contrast, the present invention is analogous to a system whereby a student is taught subject matter, and then tested on it, and continues with this teaching/testing process until the testing indicates that the child has achieved a level which will allow them to be successful in third grade. For one child that might be completed in 30 days, for another child it might be 180 days, and for another child it might be 300 days. The number of generations will vary depending upon at what point the student "plateaus" at a level where they are able to succeed in the next grade level. Obviously the number of generations in the latter example will not be infinite; however, it is variable in nature and is not predetermined, in contrast to the constant, predetermined number of generations used by Chidambaran.

To summarize, the present claimed invention specifically claims the use of a genetic algorithm; the Chidambaran et al. reference is specifically limited to genetic programming.

Further, the genetic algorithms of the present invention are continually repeated until a plateau is reached, which results in an optimized rule set; the development taught in the Chidambaran et al. reference, simply evolves for a predetermined number of generations, regardless of the outcome. For these reasons alone, the present claimed invention as claimed in claims 1 and 9, and all claims depending therefrom (claims 2-8 and 10-20), patentably define over the prior art and are in condition for allowance.

B. The Examiner improperly rejected claims 3-6, and 10-13 under 35 U.S.C. §103(a) as being unpatentable over Chidambaran et al. in view of U.S. Patent No. 5,727,130 to Hung.

In item 7 on pages 9-12 of the final Office Action, the Examiner rejected claims 3-6, and 10-13 under 35 U.S.C. §103(a) as being unpatentable over Chidambaran et al. in view of U.S. Patent No. 5,727,130 to Hung.

The Examiner has not Established a *prima facie* Case of Obviousness

As set forth in the MPEP:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skilled in the art, to modify the reference or to combined reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP 2143

These claims depend from independent claims 1 and 9 which, as noted above, patentably define over the prior art. The addition of the Hung reference does not render these

claims obvious. The Examiner asserts that U.S. Patent No. 5,727,130 to Hung teaches evolving features of random rules at column 123, lines 6-10. This is incorrect. The cited portion of Hung teaches the production of chromosomes representing "input membership functions and rules for a fuzzy logic system." Applicant admits that Hung teaches the evolution of fuzzy rules using GA's, see specification, page 5, lines 11-19. As further set forth therein, however, Hung does not teach or suggest the evolution of "variables, such as features, qualifiers, and operators ...".

Each of claims 3-6 and 10-13 specifically claim the evolution of features, qualifiers and/or operators. Thus, Hung fails to teach or suggest the recited elements of claims 3-6 and 10-13. Accordingly, these claims patentably define over both Chidambaran et al. and Hung, either taken alone or in combination.

10. CONCLUSION

For the foregoing reasons applicants respectfully request this Board to overrule the Examiner's rejections and allow claims 1-20.

Respectfully submitted:

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Date

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APPENDIX A

CLAIMS INVOLVED IN THIS APPEAL:

1. A method for deriving an optimized rule set for a fuzzy logic system, said method comprising the steps of:

generating a pool of random rules having a fitness function and storing said random rules;

evolving said random rules using a genetic algorithm to improve the fitness function of said rules in said random rule set until the overall fitness function of said rules plateaus, thereby generating an optimized rule; and

storing said optimized rule in an optimized rule storage area, said rules stored in said optimized rule storage area comprising said optimized rule set.

2. A method as set forth in claim 1, wherein said generating step includes the steps of:

checking said optimized rule storage area to determine if it contains any optimized rules; and

using any optimized rules contained in said optimized rule storage area when generating said pool of random rules.

3. A method is set forth in claim 1, wherein said evolving step comprises evolving the features of said random rules.

4. A method is set forth in claim 1, wherein said evolving step comprises evolving the qualifiers of said random rules.

5. A method is set forth in claim 1, wherein said evolving step comprises evolving the operators of said random rules.

6. A method is set forth in claim 1, wherein said evolving step comprises evolving the features, cases, qualifiers, and operators of said random rules.

7. A method as set forth in claim 1, wherein said generating, evolving, and storing steps are repeated until a predetermined number of rules are stored as said optimized rule set.

8. A method as set forth in claim 7, wherein said repeating of said steps occurs on a real-time basis.

9. At method for deriving an optimized rule set for a fuzzy logic system for use in stock market analysis, said method comprising the steps of:

generating a pool of random rules having a fitness function and storing said random rule;

evolving said random rules using a genetic algorithm to improve the fitness function of said rules in said random rule set until the overall fitness function of said rules plateaus, thereby generating an optimized rule;

storing said optimized rule in an optimized rule storage area, said rules stored in said optimized rule storage area comprising said optimized rule set;

applying a stock market data set to said optimized rule set; and

outputting a stock market analysis result based on the application of said stock market data set to said optimized rule set.

10. A method is set forth in claim 9, wherein said evolving step comprises evolving the features of said random rules.

11. A method is set forth in claim 9, wherein said evolving step comprises evolving the qualifiers of said random rules.

12. A method is set forth in claim 9, wherein said evolving step comprises evolving the operators of said random rules.

13. A method is set forth in claim 9, wherein said evolving step comprises evolving the features, cases, qualifiers, and operators of said random rules.

14. A method as set forth in claim 9, wherein said generating, evolving, and storing steps are repeated until a predetermined number of rules are stored as said optimized rule set.

15. A method as set forth in claim 14, wherein said repeating of said steps occurs on a real-time basis.

16. A method as set forth in claim 9, wherein said stock market data set comprises data regarding a particular stock choice.

17. A method as set forth in claim 9, wherein said stock market data set comprises data regarding a particular stock market.

18. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising a particular segment of stocks.

19. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising mutual funds.

20. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising futures.